Patent Application of
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for

Combined Wet and Dry Etching Process for Micromachining of Crystalline Materials

RELATED APPLICATIONS

[0005] The present application claims the benefit of priority from copending provisional patent application 60/266,931 filed on 2/7/2001 and which is hereby incorporated by reference.

FIELD OF THE INVENTION

[0010] The present invention relates generally to micromachining. More particularly, the present invention relates to a new method for combining directional ion etching and anisotropic wet etching. The present invention is particularly applicable to silicon micromachining.

BACKGROUND OF THE INVENTION

[0015] Silicon optical bench chips often have anisotropically etched Grooves for holding optical fibers or other components. Also, SiOB chips can have dicing saw cuts that function as fiber stops, thereby providing passive longitudinal alignment for an optical fiber. Such optical bench chips are well known in the art.

[0020] In some cases, it is not desirable or practical to have dicing saw cuts. Particularly, dicing saw cuts can be undesirable because they typically must extend across an entire wafer.

[0025] It would be an advance in the art to provide fiber stops in optical bench chips without requiring dicing saw cuts.

[0030] Also, it would be an advance in the art of micromachining to provide a wider array of precision-made structures. Particularly, it would be advance to combine multiple micromachining techniques to provide unusual, useful structures.

DETAILED DESCRIPTION

[0035] The present invention provides a method for making novel micromachined structures by a combination of dry and wet etching. In the present method, a pit is formed by dry etching (a dry pit), the dry pit is coated with a hard mask material, and then an area adjacent to the dry pit is etched with an anisotropic wet etchant. Preferably, the method is performed in <100> silicon. The hard mask material can be silicon oxide or silicon nitride, for example. The pit formed by anisotropic wet etching can be a Groove, for example. There are several variations on the present method included in the present invention.

[0040] The present invention can be used to make a wide range of novel micromachined structures:

[0045] 1) Grooves that do not have a 'wedge' at an end of the groove.

[0050] 2) Optical submounts that do not require a dicing saw cut for a fiber stop.

[0055] 3) Micromachined structures that have protected convex corners, without requiring well known 'corner compensation'.

[0060] 4) Optical submounts that can locate a laster or detector very close to a ball lens, without requiring the laser to over hang the lens pit.

[0065] 5) Grooves disposed below a top surface of a substrate.

[0075] It will be clear to one skilled in the art that the above embodiment may be altered in many ways without departing from the scope of the invention. Accordingly, the scope of the invention should be determined by the following claims and their legal equivalents.